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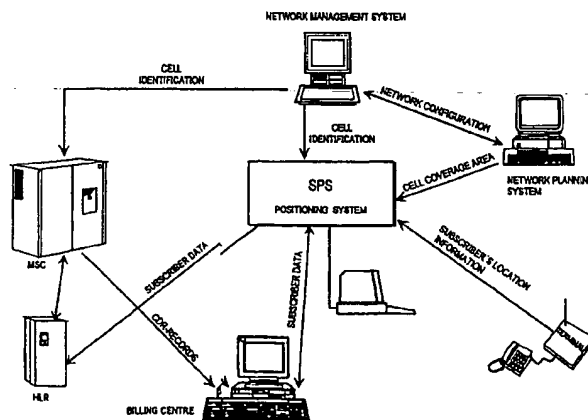
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(57) Abstract

The invention relates to a subscriber positioning system in a cellular telephone system. On a geographic information system GIS is built a software using data retrievable from the telephone system and digital maps of the geographic information system. Cell coverage areas of the radio network are displayed graphically on these maps. Subscriber information including the location of the subscriber is inputted to the subscriber positioning, which on the basis of the location determines a home cell for the subscriber, and whether more cells have to be assigned as home cells. Subscriber data can be transmitted to various databases like home location register HLR, the billing system etc. When amendments, such as insertion of new cells or changes in the cell identifications, are made in the network planning system and in the network managing system, the new data are inputted to the subscriber positioning system, which checks if there is a need to change the home cells of the subscribers.

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## A system of controlling subscriber data

### Field of the invention

This invention generally concerns control of subscriber data in a telephone system comprising at least a radio network planning system, a network management system, base stations and wireless subscriber terminals and wherein a part of the subscriber connection is formed by a radio link between a subscriber terminal and a base station. The invention especially concerns setting of a home cell or home cells for a subscriber in a cellular mobile telephone system and in a wireless local loop system.

### Background of the invention

In building a fixed telephone network, the installation of subscriber lines between the exchange and subscriber terminals is both a considerable cost item and also a measure demanding much time. Maintenance of subscriber lines is a major cost item also in network maintenance. In scarcely populated areas in particular, costs may be high for the individual connection. One solution for reducing costs is to replace the fixed subscriber loop between exchange and subscriber terminal with a radio connection.

A system embodying a wireless subscriber loop can be implemented either by connecting the base stations by way of a special network element called an access node to the telephone exchange of a fixed network or by utilizing an existing mobile telephone system either as such or by removing some network elements and/or by simplifying some functions. The name WLL system (Wireless Local Loop System) is used in this application as a common name for these solutions.

Figure 1 shows the principle of a WLL system based on a fixed network. A wireless fixed terminal 4 comprises a radio unit equipped with an aerial and a telephone adapter connecting a standard subscriber device 5 with the terminal. The subscriber device may be an ordinary telephone, a telefax or a modem and it is connected to the terminal by pushing a standard plug into the terminal's adapter connection. The user operates the subscriber device 5 in the same way as in a normal fixed network, although a major part of the subscriber line connection is formed by a radio link between the terminal 4 and the base station 2. The subscriber device and the terminal can be combined to form one physical equipment 6. Each base station may serve

several subscriber terminals. The base stations are connected to a special access node 1, which for its part is connected to a standard telephone exchange.

Access node 1 is connected to the local exchange with a multiplexer using 2 Mbit/s PCM system of the open V2 or V5.1 type. If the local exchange supports a 2-wire connection only, the access node is connected to the exchange by converting V2 signalling into an analog 2-wire subscriber connection interface with the aid of the multiplexer. Signalling between the access node and the base stations connected to it is the signalling of an applied mobile telephone network, for example, a NMT or GSM network, however, modified in such a way that functions typical of a cellular network, such as cell handover and roaming, are left out. Thus, the subscriber must stay within the coverage area of that base station determined to it. The subscriber access node converts the signalling of the WLL network into signalling suitable for a fixed network (for example, PSTN) and, correspondingly, adapts the signalling of the fixed network into the WLL network interface. Routing of incoming and outgoing calls is based on the subscriber data file located in the subscriber access node.

A WLL system based on a mobile telephone network is constructed so that structural elements of some existing cellular system are applied. Hereby the signalling in the WLL system is in accordance with the system in question, the base stations are standard base stations of the system in question and the radio unit of the terminal is of the same type as the radio unit of the mobile station. The subscriber access node connecting subscribers to the standard local exchange is an important component of the WLL system. In a pure cellular system it is a mobile telephone exchange and in an applied system it is an access node to be described later.

Figure 2 shows the main structural features of a known mobile telecommunication system. The network comprises several interconnected mobile services switching centres MSC. The MSC centre may establish connections with other MSC centres or with other telecommunication networks. Several base station controllers BSC are connected to the MSC. Base stations BTS are connected to each base station controller. The connection with the mobile station MS is always through a base station. Data is collected from the network and access nodes are configured with the aid of a network management system NMS. A billing centre collects call data records

CDR sent by the mobile services switch centres and based on these it forms the telephone bill for the subscriber.

The mobile telephone network also includes different databases. Subscriber data is stored permanently in a home location register HLR regardless of the subscriber's current location. Subscriber service data, among  
5 other data, is stored in the register and routing data is stored in the visitor location register VLR. Subscriber data available from the HLR is stored in the visitor location register for the time of the subscriber's visit to the VLR area.

The mobile telephone network is suitable as such for WLL terminals. Information on that the subscriber is a WLL subscriber and data telling in which cell's area the subscriber resides are facts which are stored in the home location register HLR. This cell is called the subscriber's home cell. The subscriber may have the right to receive and start calls only in the area of this cell, in Figure 2 terminal 21 could function in the cell A only. In practice, such a situation might occur where the geographical location of the WLL  
15 terminal is in an area where the best audibility is obtained in more than one cell depending on radio conditions. In Figure 2 such an area is marked with the letter D and from this area the best connection can be obtained either to cell A, B or E, depending on radio conditions. Hereby these cells A, B and E are defined as home cells for the WLL subscriber. Handover may then be  
20 allowed between these base stations.

Irrespective of the subscriber's mobility, one cell or several cells can be named as home cell in a mobile station network, whereby calls started from and received in the home cell are cheaper. The applicant's  
25 patent applications FI-9460911 and FI-946092 present some ways of implementing this. According to these, in the call establishment the exchange analyses whether the calling subscriber's location cell and/or the called subscriber's location cell belong to a group of special cells. Different charge rates can then be varied if the subscribers are in a group of special cells. The  
30 functions could also be based on an intelligent network IN, wherein the service switching centre SCP performs the analysis and applies the special charging basis which has been set for the group.

Principles like the one described above are also applicable to the setting of the WLL subscriber's home cell or home cells.

35 A prior art telephone system has several drawbacks resulting from the home cell or home cells. At present it is very problematic for the operator

to know the subscriber's home area and the cells of the home area, from which area the subscriber may make/receive a call. This is due to the following circumstances:

5 The operator has no up-to-date data on the coverage area and field strengths in the billing centre BC, so when the subscriber states himself to be a WLL subscriber, he is not able at once to determine the subscriber's home area and its cell identifiers nor to store cell data of different home areas in a database, such as MSSC/HRL or a similar database. For this reason, the operator must get in touch with the network planning or field staff to  
10 make sure that there is a sufficiently powerful coverage area at the subscriber's address and to learn the home area cells and cell identifiers which can be determined for the subscriber. The fact is that it is not possible to see clearly from the address stated by the subscriber whether there is any network at all at the subscriber's address. Thus one must make clear if a WLL  
15 connection can be given to the subscriber and a visit must be made to the address in question to measure the network strength.

The operator has no such system wherein identifiers of cells covering the subscriber's address could be stored, so that it could be possible based on the address stated by the subscriber to check which cells cover the  
20 place of location. After cell identifiers of the subscriber's home area have first been clarified in some way, they must be stored manually in the subscriber database, one by one.

When the network is developed and cell locations and numbers are changed, the subscribers' home areas will also change, whereby the  
25 home area data of each subscriber must be checked manually for each subscriber and changed data must be corrected so that the subscribers can again call from their home areas. This may lead to a situation where during the work a WLL subscriber cannot make or receive any calls.

The aim of this invention is to bring about such a system which  
30 has no drawbacks of the state-of-the-art system and which allows real time management of subscriber data, especially of subscriber home cells, by using a graphic user interface.

The established objective is achieved through the solutions defined in the independent claims.

### Summary of the invention

The invention is based on the insight of using a known geographic information system (GIS) so that on top of this is a special programme utilizing network configuration data and cell data presently retrievable from a telephone system and digital maps of the geographical information system to  
5 determine the subscriber's home cell as a part of the subscriber data. Thus, the system as a whole is a system of controlling subscriber data and the name used for this hereinafter in this application is Subscriber Positioning System SPS.

10 The functionality of the subscriber positioning system or SPS is formed by management of digital maps and by their display in a GIS system and by graphic display of the coverage area and field strength of radio network cells on a map in a GIS system. Radio network data and cell identifiers are entered into the subscriber positioning system using a first input arrangement.  
15 Hereby the graphic display shows a geographical map with the desired exactness and it shows cell borderlines and, if desired, also field strength curves within cells. This can already be used for various useful purposes.

Usefulness increases when subscriber information, the subscriber's position included, is also supplied to the subscriber positioning system using a second input arrangement. Hereby the subscriber's position binds the subscriber to a certain point on the map and thus to a certain cell visible in the display, and according to this it can be seen whether one cell is enough as home cell or if more cells must be assigned as home cell. When a  
20 new subscriber enters the network it is easy to establish the home cell or home cells according to the position. If the position is not exact, the subscriber may use a display means to show the position of his terminal on the map, and based on this the operator is able forthwith to determine the home cell. The position information may be the terminal's coordinate information,  
25 street address or like.  
30

When radio network data and subscriber data have been supplied to the system, subscriber data can be retrieved and printed out by applying different retrieval principles. It is easy to transfer identification data of the subscriber's home cells to various databases, such as the home location register HLR, the billing system etc.  
35

When changes are made in the network, e.g. when cells are added or cell identifiers are changed, the new network configuration and the new identifiers are input to the subscriber positioning system, which will check which subscriber home cell data need to be changed.

5

#### **Brief description of the drawings**

The invention is described in greater detail in the following by referring to the enclosed schematic drawings, of which

- 10 Figure 1 depicts a WLL system;
- Figure 2 shows another WLL system;
- Figure 3 shows a known GIS system in a simplified form;
- Figure 4 shows the subscriber positioning system and its inputs;
- Figure 5 shows coverage areas of some cells;
- 15 Figure 6 depicts a geographical area in coverage areas of cells;
- Figure 7 illustrates a possible view produced by the subscriber positioning system on the display; and
- Figure 8 shows the subscriber positioning system adapted for a mobile telephone network.

20

#### **Detailed description of the invention**

- Figure 3 shows main blocks in a geographic information system GIS known as such. According to one definition, the GIS system is an integrated system of computer hardware, software, and trained personnel linking
- 25 topographic, demographic, utility, facility, image and other resource data that is geographically referenced. A usual way is to present different matters on a map, such as, for example, population distribution, traffic distribution etc. The system has a big database containing objects with their geographical relations, software tools for processing objects and application software. The
  - 30 input is an abstraction of a geographical area, often a digital map.

- The subscriber positioning system SPS according to the invention which is outlined in Figure 4 comprises a GIS system working in a computer and a programme built on it which produces desired outputs from given inputs. In this example, the input in the GIS part is a map of Finland in digital
- 35 form in the desired, usually small scale. It is advantageous for the map also to contain position data or at least name data of places. Position and name



data can also be transferred separately, provided that the geographical linking of each address to the map is attended to. The digital map is stored in a database. Other input of the subscriber positioning system SPS is radio network data, whereby the SPPS shows drawn on the map of the GIS software and in a graphic form the network, the field strength of its radio coverage, subscriber data, the home areas and the positions of the subscribers.

Henceforward a WLL subscriber is used as an example but it is clear that the subscriber also could be a subscriber in an ordinary mobile telecommunications network.

The radio network data required for the input is obtained from the network planning system. In the planning of the WLL network the network planning software is used to model the locations of network cells, their number and field strengths. The cell border is formed by an area, wherein field strength has dropped below an accepted value. The result is a network configuration which is input to the network management system, if such a system is used. The network management system assigns a cell identifier (cell ID) for each cell. The cell identifiers are transferred to the subscriber positioning system SPS.

The cell coverage area produced by the network planning system can be presented as a set of curves in accordance with Figure 5, which here shows three cells A, B and D.). The thicker continuous line is the cell border and the lines inside it outline field strengths of the base station within the cell. Information concerning cell coverage area and radio network strength, of which the curves in Figure 5 are only a part, presents the whole network and it is transferred in electronic form into the database of the subscriber positioning system SPS. The transfer may take place, for example, in ASCII mode. For the system according to the invention to operate correctly, the radio network information must be consistent with the real network.

Figure 6 outlines a map given by the GIS system from the same area where the cells of Figure 5 are located. Depending on accuracy, the map may show lakes, roads, houses, hills, fields etc.

The subscriber positioning system SPS is now able to show the WLL network drawn graphically on the map and the strength of its radio coverage. In the case of Figures 5 and 6 the result could be like the one shown in Figure 7. The identifier for the cells visible on the display can also

be presented on the display or it can be made visible by clicking the mouse on the cell.

The system can be utilized even at this stage. When the customer inquires if the network has such good coverage at some geographical place that the radio connection will work, the operator may check the situation on the display. By locating the display, for example, in a shop, the seller of the terminal can check forthwith that there is sufficient audibility at the terminal's intended area of location.

When a new WLL subscriber arrives, he gives information on the location where the WLL terminal will be located. The operator inputs the location data into the system, which in a view of the type shown in Figure 7 shows the future position for the terminal, for example, with a flashing dot. The system immediately indicates the cell in the coverage area of which the terminal is located. This cell is defined as the subscriber's home cell. The identification data of this cell is added to the subscriber database. Only calls made from this cell or received in this cell are permissible or, in a less strict case, they are cheaper than such calls of the subscriber which take place elsewhere in the network. If the dot is in position P in Figure 7, it is immediately obvious that the terminal is located at the borders of cells B, D and A, whereby depending on radio conditions the best connection can be obtained with any base station of these cells. These cells are hereby defined as the subscriber's home area, that is, home cells. The cell identifiers are supplied to the subscriber database.

Correspondingly, the subscriber positioning system SPS may be used in such a way that when the subscriber complains about a poor connection, the subscriber's position data is input to the system, whereby it is possible to see the home area and its field strengths on the graphic display. This allows conclusions to be drawn as regards the cause of the poor connection.

When a subscriber becomes a WLL subscriber it is advantageous to store in the subscriber positioning system SPS as full subscriber data as possible, for example, the subscriber's name, position, the terminal's telephone number and the home cell identifiers. The home cell identifier is given automatically by the system.

Retrieval and printout of subscriber data can be easily performed by various retrieval principles, for example, according to the subscriber's name, address or number.

For the WLL network to be able during a call establishment to  
5 check whether the call is permissible, the cell identification data of the subscriber's home area must be transferred to the home location register HLR in the case of the cellular network in Figure 2 or to the subscriber database of the subscriber access node in the case shown in Figure 1. The data may also have to be transmitted to the billing system, whereby it identifies from  
10 the received call-based CDR file that the cell is a home cell and uses a corresponding basis for billing the price of the call. This is necessary in case of a cellular network when the subscriber device is a mobile station which can move anywhere in the network.

It is easy in the subscriber positioning system SPS to create, re-  
15 move and change subscriber data. If the subscriber's home area and position change, the new position is obtained from SPS by supplying the new home area, and this data is supplied further to the home location register HLR or to any similar register and to customer billing. If a new network configuration is made in the radio network's planning system, it is transferred to  
20 the SPS, whereby the SPS defines new home areas for subscribers, whose home area or home area cells have changed.

Figure 7 shows a system in accordance with the invention applied in a WLL system based on a cellular network. The cellular system may be a GSM or DCS1800 system. The latter is based on the former and differs from  
25 that mainly as regards its frequency band. The main network elements of the cellular system have been described earlier in connection with Figure 2. The subscriber positioning system SPS is connected to the cellular network so that the network planning element transmits the coverage area of the cells to the subscriber positioning system in such a form that it can be linked to the geographical map in the SPS. The network management element, which has  
30 also received the network configuration, provides the cells with cell IDs. These are entered into the subscriber positioning system SPS and into the mobile services switching centre MSC. The cells of the WLL network with their identifiers are now available on the map in the subscriber positioning  
35 system. For each WLL subscriber, at least the position data, for example, the physical address, the subscriber's name and telephone number, are entered

into the subscriber positioning system. From this data the system gives the subscriber's home cell or home cell identifiers automatically. Together with the subscriber data mentioned above they form the subscriber data file. This is entered into the billing centre and the home location register HLR. The

5 VLL network now has all necessary information for controlling the subscriber's calls. When the network configuration changes the new cell coverage area and the new cell identifiers are entered into the subscriber positioning system SPS, which automatically gives new home cells to those subscribers, whose home cells change when the network changes. The

10 changed subscriber data is transmitted to the home location register and to the billing centre.

Correspondingly, changes in the subscriber position data are entered into the subscriber positioning system, which updates the subscriber file in a proper manner.

15 The cell coverage area data and cell identifier data may be entered into the subscriber positioning system SPS as a direct file transfer. In the same way, subscriber data produced by the subscriber positioning system can be transferred to the home location register or to the subscriber database of the subscriber access node and to the billing centre. It is also

20 possible to transfer this data with a storing medium, such as a CD disk, a tape or any other such means.

On the practical level, the subscriber positioning system can be embodied in many different ways within the scope defined by the claims. Data can be entered into the system in several different ways. Subscriber

25 data can be entered in a centralized or decentralized manner from several operator offices. The terminal may contain a positioning system, for example a Global Positioning System GPS. Hereby the terminal may itself state its position to the subscriber positioning system. Another way is such that when the subscriber has acquired the terminal, a representative of the operator

30 visits its place of location and using a special positioning system he registers the position, which he then reports to the system by radio or in some other way. The home cells of subscribers can possibly be defined already in the planning system of the radio network at the stage of network planning. New subscribers and changes concerning old subscribers arriving after the intro-

35 duction are hereby entered afterwards into the subscriber positioning system. The graphic view produced by the system can also be transferred to the

display of a computer in the operator's office. Physically, the subscriber positioning system can be located in connection with any network element.

- The invention is suitable for use in case of a WLL network connected through a subscriber access node to the exchange and also in connection with a mobile telephone network having a cellular structure, where a
- 5 WLL connection can be offered to the subscriber

### Claims

1. A subscriber positioning system in a cellular telephone system comprising;
  - a network planning system where network configuration data are stored,
  - a network managing system where cell identification data are stored
  - and in which a part of a subscriber connection comprises a radio connection between a subscriber terminal in a cell and a base station serving the cell,
  - characterized in that the subscriber positioning system comprises:
    - a first software for forming a geographical map,
    - network configuration data which are, by using a first input arrangement, fetched from the network planning system and fed into the subscriber positioning system,
    - cell identification data which are, by using the first input arrangement, fetched from the network managing system and fed into the subscriber positioning system,
    - a second software for showing the cell areas of the telephone system on the geographic map in a display.
    - geographic location data about predetermined subscriber terminals which are, by using a second input system, fed into the subscriber positioning system,
    - and in response to the inputted information about the location of a terminal the subscriber positioning system determines the cell in which the terminal resides.
2. A system according to claim 1, characterized in that the first software includes a geographic information system GIS known as such.
3. A system according to claim 1, characterized in that in the second input arrangement the location is reported by the terminal itself.
4. A system according to claim 1, characterized in that in the second input arrangement the location is reported by geographic positioning equipment located by the terminal.

5. A system according to claim 1, characterized in that the radio network information comprises cell coverage areas and information about field strength.

5 6. A system according to claim 1, characterized in that in the second input arrangement at least the subscriber's name and telephone number are inputted as the subscriber data.

7. A system according to claim 6, characterized in that in response to the inputted subscriber data the second software fixes as a subscriber's home cell at least the location cell of the terminal and generates an output subscriber data record comprising at least the inputted subscriber data and the home cells of the subscriber.

8. A system according to claim 6, characterized in that in response to the inputted subscriber data  
the second software determines the subscriber's location cell,  
15 with the aid of the software a user selects at least one home cell for the subscriber,

the second software generates an output subscriber data record comprising at least the inputted subscriber data and the home cells of the subscriber.

9. A system according to claim 7 or 8, characterized in that a special charging basis is applied to the calls performed in the home cell.

10. A system according to claim 7 or 8, characterized in that it includes means for transmission of the output subscriber data record at least to one subscriber database of the telephone system.

11. A system according to claim 7 or 8, characterized in that it includes means for transmission of the output subscriber data block to the billing system of the telephone system.

12. A system according to claim 7 or 8, characterized in that the output subscriber data block is retrievable and printable by using any of the parameters of the subscriber data record.

13. A system according to claim 1, characterized in that the telephone system is a wireless local loop system.

14. A system according to claim 1, characterized in that the telephone system is a cellular mobile communication network.

15. A system according to claim 1, characterized in that it is implemented by utilizing functions of an intelligent network.

16. A system according to claim 1, characterized in that after the radio network configuration has been changed by the network planning system, information about the new configuration is fed into the subscriber positioning system.

5           17. A system according to claim 1, characterized in that after the identifier of a cell has been changed by the network managing system, the changed cell identifiers are fed into the subscriber positioning system,

10           in response to the changed cell identifiers the subscriber positioning system upgrades location data of the pertinent subscribers.



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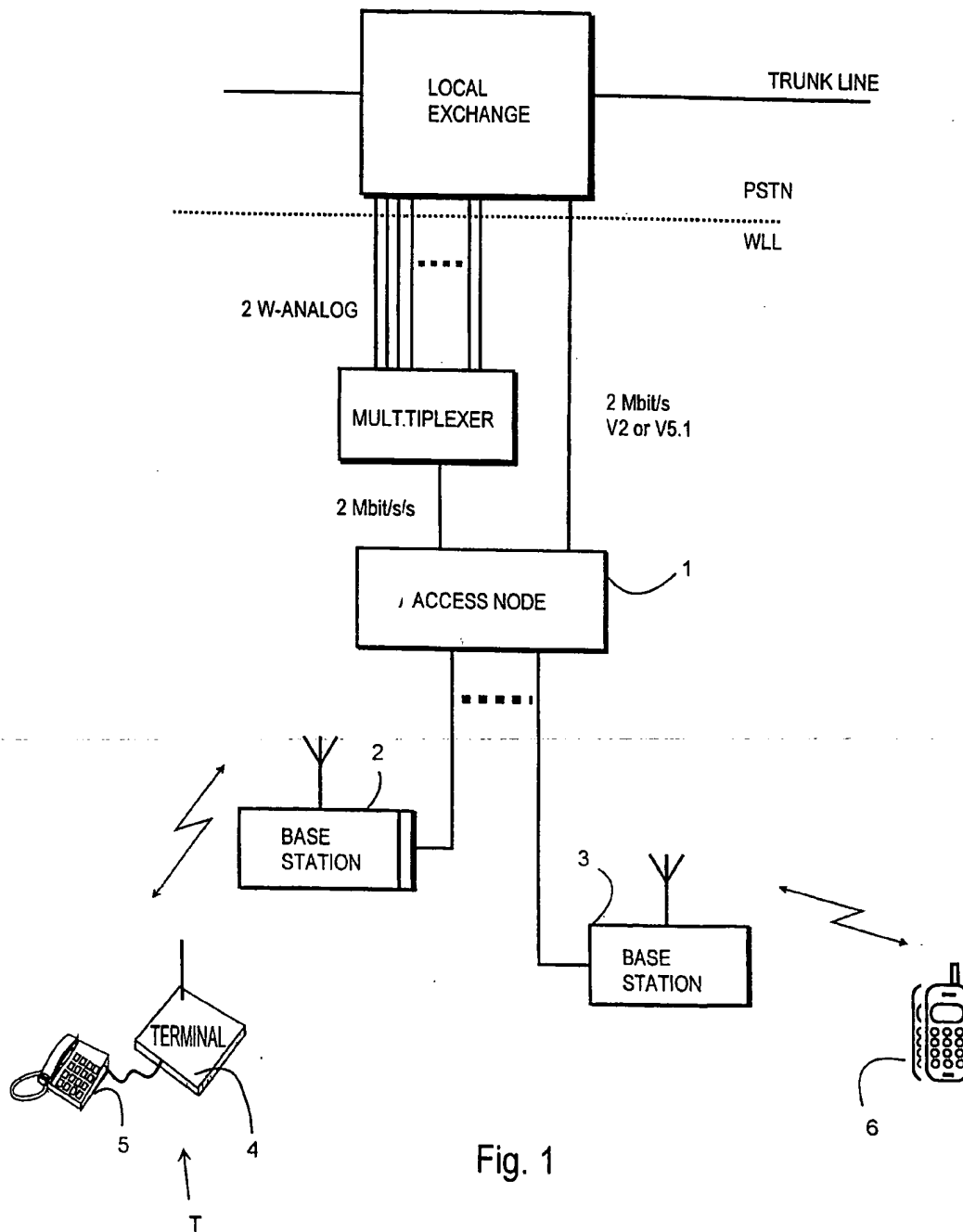
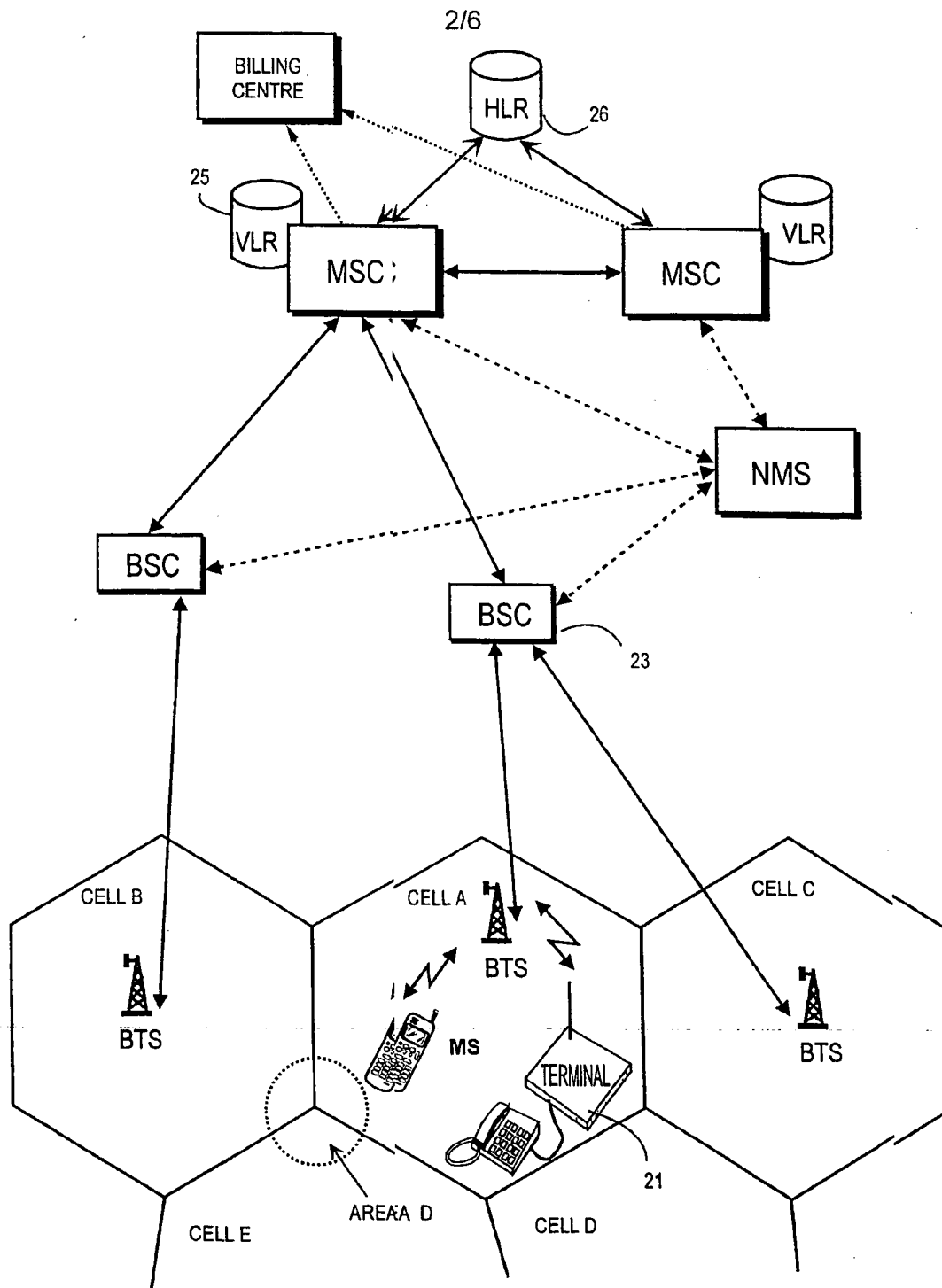


Fig. 1



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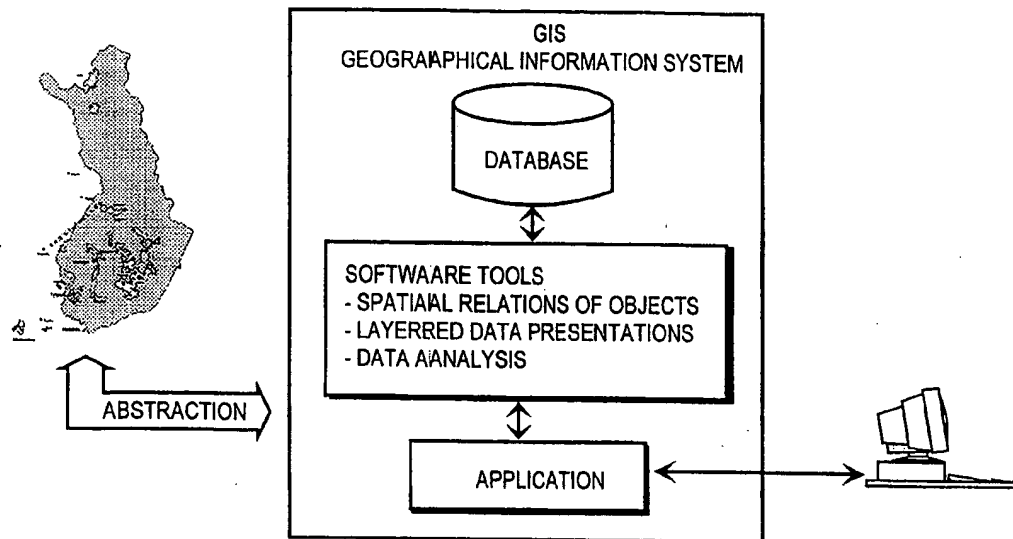


Fig. 3

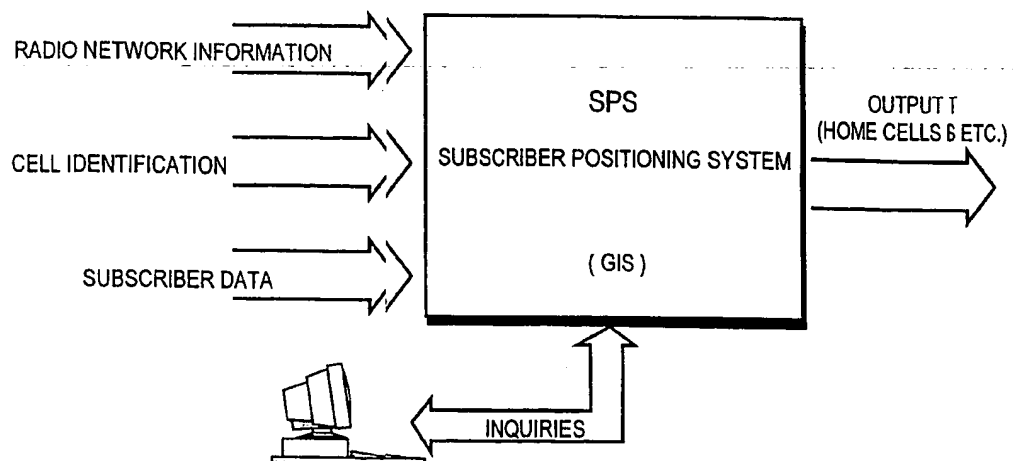


Fig. 4

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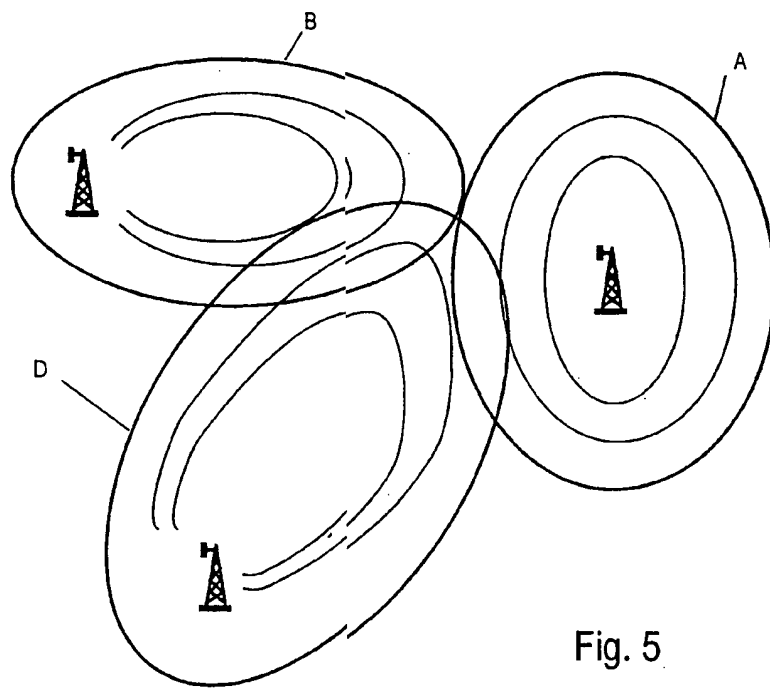


Fig. 5

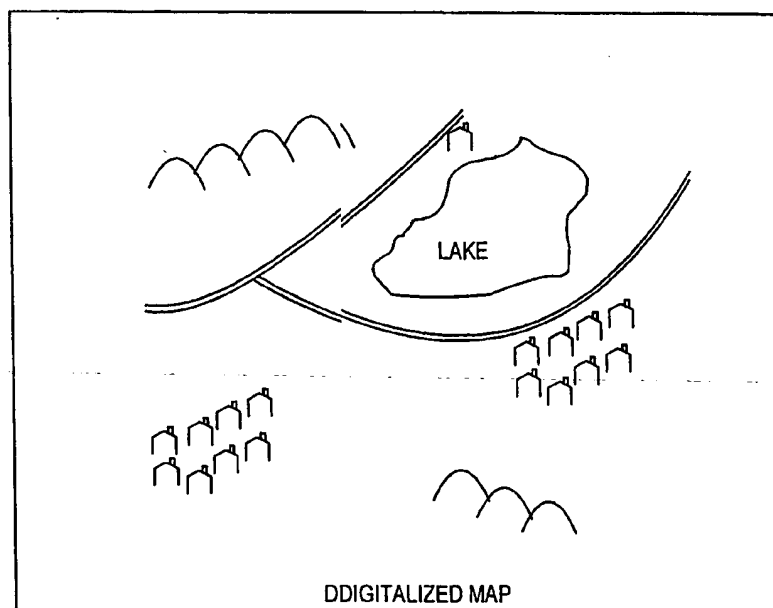


Fig. 6

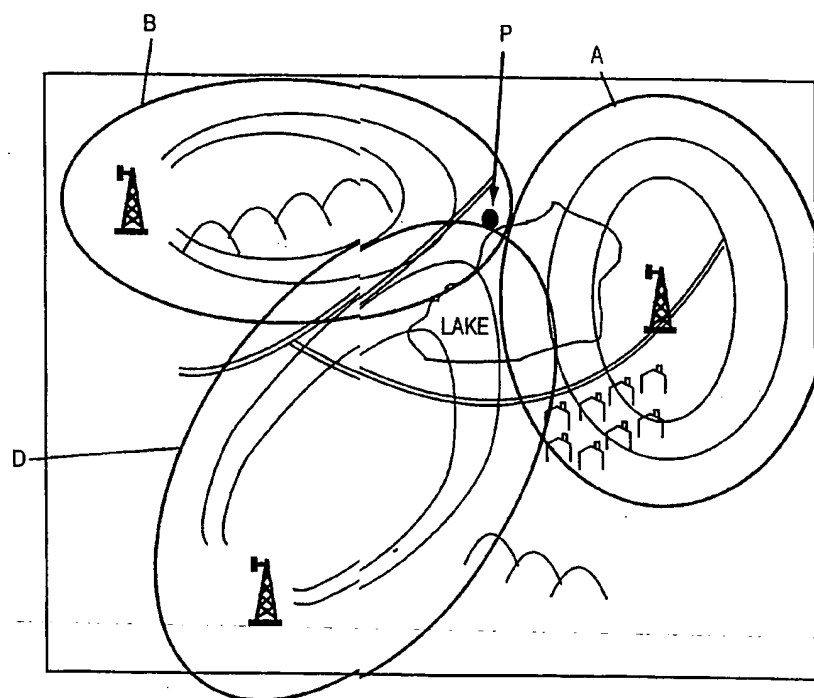


Fig. 7

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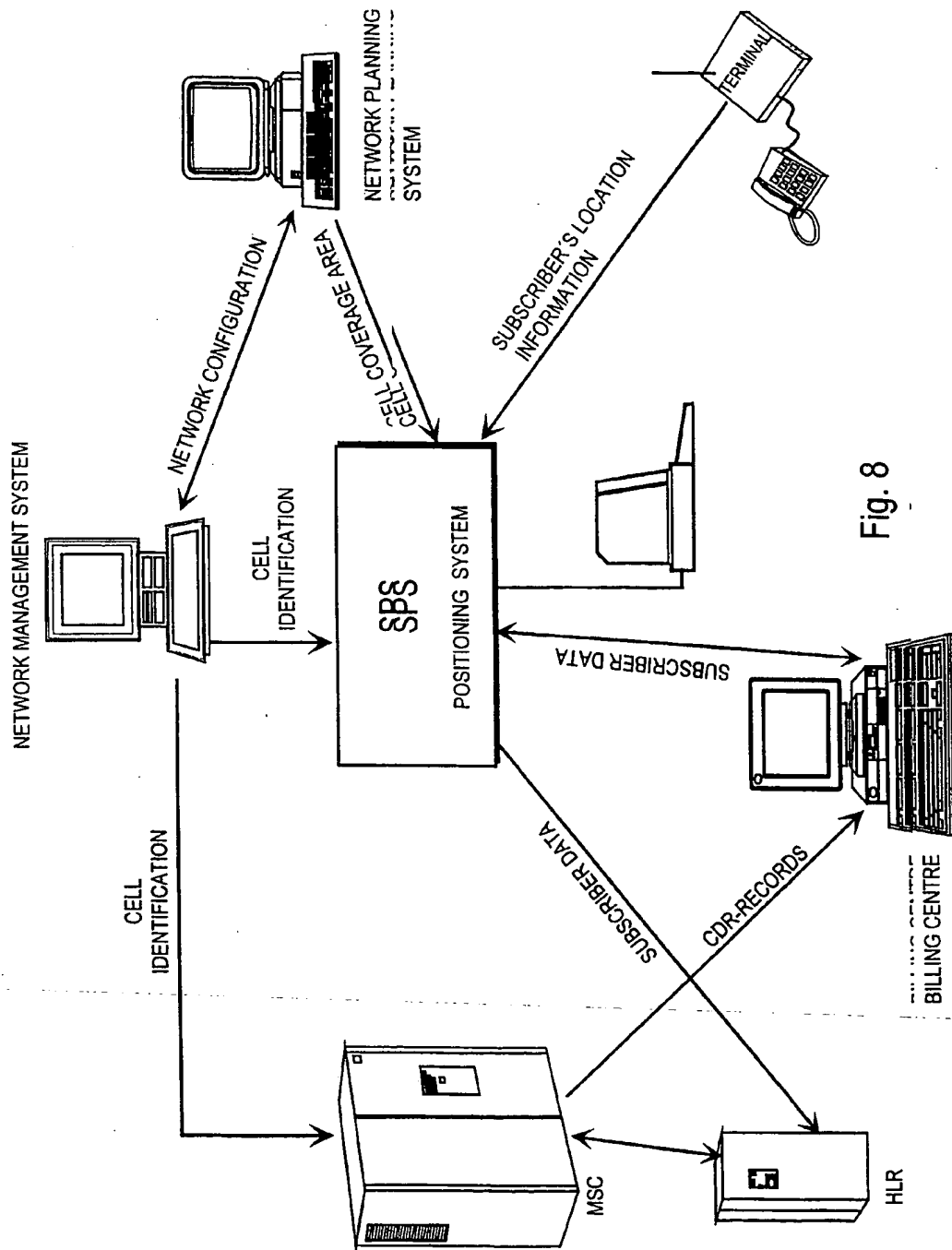


Fig. 8

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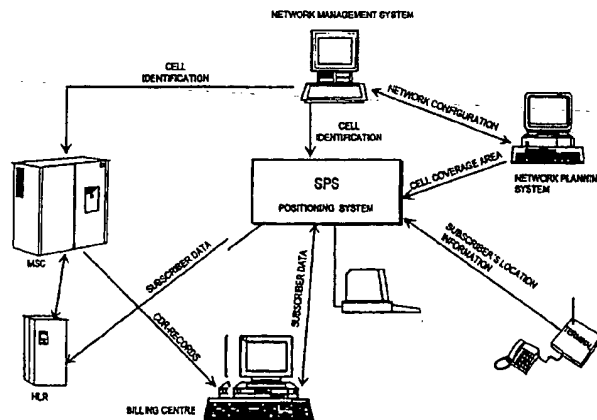
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(54) Title: A SYSTEM OF CONTROLLING SUBSCRIBER DATA IN A CELLULAR TELEPHONE SYSTEM



(57) Abstract

The invention relates to a subscriber positioning system in a cellular telephone system. On a geographic information system GIS is built a software using data retrievable from the telephone system and digital maps of the geographic information system. Cell coverage areas of the radio network are displayed graphically on the map. Subscriber information including the location of the subscriber is inputted to the subscriber positioning, which on the basis of the location determines a home cell for the subscriber, and whether more cells have to be assigned as home cells. Subscriber data can be transmitted to various databases like home location register HLR, the billing system etc. When amendments, such as insertion of new cells or changes in the cell identifications, are made in the network planning system and in the network managing system, the new data are inputted to the subscriber positioning system, which checks if there is a need to change the home cells of the subscribers.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 98/00677

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>				
IPC6: H04Q 7/36, H04Q 7/38 According to International Patent Classification (IPC) or to both national classification and IPC				
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<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
X	EP 0431956 A2 (MOTOROLA, INC.), 12 June 1991 (12.06.91), column 2, line 54 - column 3, line 29; column 4, line 56 - column 6, line 28  ---	1-3,5-122,14,16		
X	WO 9722940 A1 (MCI COMMUNICATIONS CORPORATION), 26 June 1997 (26.06.97), page 3, line 1 - page 4, line 2, abstract  ---	1-4,6-8		
A	US 5602903 A (FREDERICK W. LEBLANC ET AL), 11 February 1997 (11.02.97), column 7, line 43 - column 10, line 36  ---	1-17		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.				
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International application No.

PCT/FI 98/00677

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A	US 5559707 A (DAVID M. DBELORME ET AL), 24 Sept 1996 (24.09.996), column 3, line 7 - column 8, line 38  --- -----	1-17

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

02/02/99

International application No.  
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